

Rocuronium versus succinylcholine for rapid sequence intubation in patients with bowel obstruction

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ABSTRACT

Introduction. The aim of the study was to determine intubation conditions in the patients receiving rocuronium in comparison to succinylcholine for rapid sequence intubation during the induction of anesthesia for operative management of bowel obstruction.

Methods. In the randomized controlled study 30 adult patients with bowel obstruction undergoing urgent surgery were randomly allocated in two groups. For muscle relaxation the S-group of patients received succinylcholine (1.5 mg/kg) and the R-group rocuronium (1.2 mg/kg). Intubation conditions were evaluated using a grading system according to Viby-Morgenson. Primary outcomes were intubation conditions 1 minute after the application of a muscle relaxant. Secondary outcome measures were heart rate, blood pressure, and pulse oximetry; potassium and myoglobin serum level.

Results. All patients were orotracheally intubated in the first attempt. During induction, we didn't observe vomiting or aspiration. Overall intubation conditions in the S-group were statistically significantly better than in the R-group. After RSI there was a statistically significant decrease in systolic and diastolic blood pressure in both groups and statistically significant decrease in heart rate in the S-group. After RSI the potassium level in the S-group was significantly higher in comparison to the R-group and serum myoglobin level non-significantly increased in the S-group and statistically significantly decreased in the R-group.

Conclusion. The results show that rocu-

nium in RSI patients with bowel obstruction enables the same intubation conditions as succinylcholine and the same risk of aspiration which allows succinylcholine replacement and avoidance of its side effects.

Key words: Rocuronium, succinylcholine, rapid sequence intubation, bowel obstruction, intubation conditions

INTRODUCTION

Bowel obstruction is a common surgical emergency often requiring urgent operative management (1).

Patients with bowel obstruction have an increased risk of vomiting and pulmonary aspiration of gastric content and require rapid sequence intubation (RSI) during the induction of anesthesia (2–4). RSI is a well-defined medical procedure used in urgent airway management in critically ill patients and during the induction of anesthesia (4–8).

The most commonly used muscle relaxant to perform RSI in the past and still today is the depolarizing muscle relaxant succinylcholine because of its excellent pharmacokinetic features (9, 10). Succinylcholine has a rapid onset and short duration of action. In case of difficult or failed orotracheal intubation, muscle relaxation is rapidly resolved; the patient starts breathing spontaneously, and the risk of pulmonary aspiration is reduced. Unfortunately, succinylcholine can cause several adverse side effects affecting blood pressure and heart rate, causing fasciculations, muscle pain and prolonged paralysis, elevated intragas-

tric, intraocular and intracranial pressure, hyperkalemia, masseter muscle rigidity, malignant hyperthermia, generalized contractions, and histamine release (3, 11–13). Rocuronium is a non-depolarizing muscle relaxant with rapid onset of action and fewer side effects than succinylcholine (10, 11, 13, 14, 16). At a higher dose it has an onset of action that approaches succinylcholine, making it a suitable alternative for RSI. Even though rocuronium has a longer duration of action, neuromuscular block can be neutralized with sugammadex in the case of a failed RSI, even when neuromuscular block is deep (11, 15–18).

Rocuronium has much less side effects compared to succinylcholine, particularly in critically ill patients with bowel obstruction (3, 11). However, the quality of vocal cord visualization, which is crucial for successful orotracheal intubation, is better with succinylcholine (19).

Succinylcholine and rocuronium can cause anaphylactic reaction, but using succinylcholine for RSI carries almost twice the greater risk for anaphylactic reaction compared to rocuronium (38).

The aim of the study was to compare intubation conditions in patients receiving rocuronium in comparison with patients receiving succinylcholine for RSI during the induction of anesthesia for operative management of bowel obstruction.

METHODS

The study was approved by the Republic of Slovenia National Medical Ethics Committee - NMEC on 29 October 2013 (registration number 104/10/13) and retrospective-

ly registered with the ISRCTN registry on 4 December 2015 (Ref: ISRCTN11777647; 20).

All patients provided a signed informed consent before randomization. Adults older than 18 years with the American Society of Anesthesiology physical (ASA) status classes 2 and 3, who had bowel obstruction and were scheduled for an urgent surgery at the University Medical Centre Maribor between December 2013 and June 2016, were enrolled in the randomized controlled study.

The exclusion criteria were increased serum potassium level, severe acute or chronic renal failure, Mallampaty score 3 or 4, and history of allergy to any of medications used in our protocol, patient ASA score more than 3 and patient refusing to participate in the study.

Patients were randomly allocated before surgery to either the succinylcholine group (S-group) or rocuronium group (R-rocuronium), using the random number generator (21). (<http://193.2.12.193/generator/generator.html>)

Anesthetic management

Patients did not receive any premedication. In the operating room the nasogastric tube and peripheral venous catheter 16-G were inserted. The gastric content was aspirated through the nasogastric tube as much as possible. The patients were preoxygenated through the facemask with a flow of 10l/min for 5 minutes. Before the induction of anesthesia, patients were monitored with electrocardiography, noninvasive blood pressure measurement, and pulse oximetry. Radial artery line was inserted and the relaxometer TOF-Watch S (Organon) was initiated on the opposite side of the arterial catheter.

Patients received a bolus of midazolam 0.05mg/kg body weight (b.w.) and fentanyl 2 µg/kg b.w. before the relaxometer was calibrated. After calibration in the R-group, TOF was measured 60 seconds after muscular relaxant application. The patients were positioned in the head-down position and the gastric content was once again aspirated. The induction of anesthesia and orotracheal intubation was performed according to the RSI protocol.

The induction to the anesthesia was continued with etomidate 0.3mg/kg b.w. Patients in the S-group received succinylcholine 1.5mg/kg b.w. and the patients in R-group received rocuronium 1.2mg/kg b.w. The Selick maneuver was performed. Indirect laryngoscopy and orotracheal intubation with Macintosh laryngoscope was performed 60 seconds after the induction.

Data collection

We collected patients demographic data (age, sex, height, weight), ASA status and hemodynamic measurements 1 minute before the induction and 1 minute after orotracheal intubation (blood pressure, heart rate and pulse oximetry), clinical intubating conditions (assessed by the anesthesiologist), intubating conditions according to the Viby-Morgenson score system (table 1), number of orotracheal intubation attempts, vomiting, aspiration, oropharyngeal and laryngeal pain after extubation. Blood samples for serum potassium and myoglobin measurement were collected through a radial artery line before the induction of anesthesia and 5 minutes after the muscular relaxant application.

Study outcomes

Primary outcomes were intubation conditions 1 minute after the muscular relaxant application, determined by response to laryngoscopy, vocal cord position and movement, and response to intubation. Secondary outcome measures were: heart rate, blood pressure and pulse oximetry, measured 1 minute before and after the orotracheal intubation; potassium and myoglobin serum level measured 5 minute before and after the muscle relaxant application.

Statistics

Data were analyzed with the IBM SPSS Statistics statistical software version 19.0 (SPSS Inc., Chicago, IL, USA). Patients' characteristics and baseline values were compared using a t-test for independent

samples, the Kruskal Wallis test, and χ^2 where appropriate. The t-test for independent samples was performed to compare the hemodynamic data between the two groups and t-test for paired samples to compare the hemodynamic data before and after intubation with baseline values. Data are presented as mean value \pm standard deviation (SD). $P \leq 0.05$ was considered statistically significant.

RESULTS

We enrolled 46 patients with bowel obstruction who underwent urgent operative management and RSI during the induction of anesthesia. Sixteen patients were excluded from the study due to increased serum potassium, renal failure, increased Mallampaty, and ASA score. Thirty patients were randomly allocated into S-group or R-group (Figure 1).

There were no statistically significant differences between both groups according to main demographic characteristics Table 2. All patients in both groups were orotracheally intubated in the first attempt. During RSI no vomiting or aspiration occurred in any of the patients.

Overall intubation conditions in both groups are listed in Table 3, according to the grading system for intubation (Table 1). Intubation conditions in S-group were excellent in 80% of patients and good in 20% of patients. In R-group, intubation conditions were excellent in 40% of patients and good in 60% of patients. In both groups we did not observe any patients

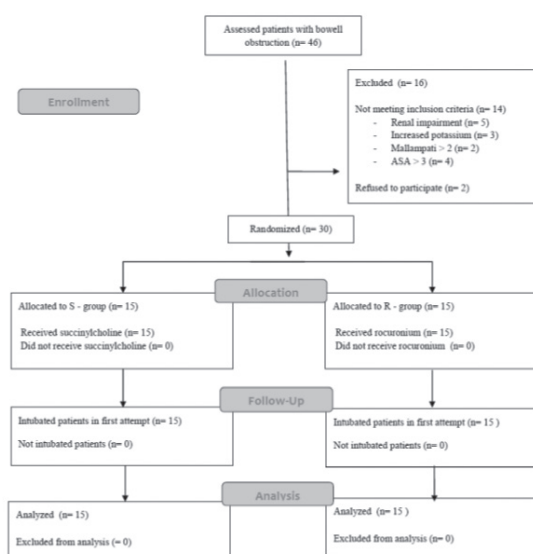


Figure 1 Study flow diagram

Table 1. Grading system for intubation conditions according to Viby-Morgenson et al. (22).

	Excellent	Good	Poor
Laryngoscopy			
Jaw relaxation	Relaxed	Relaxed	Poor relaxation
Resistance to blade	No resistance	Slight resistance	Active resistance
Vocal cords			
Position	Abducted	Intermediate	Closed
Movement	None	Moving	Closing
Reaction to intubation			
Limb movement	None	Slight	Vigorous
Coughing	None	Diaphragm	Sustained

Legend: The overall intubating conditions were graded excellent if all observed parameters were excellent. If the observed parameters were good and excellent the intubating conditions were graded good. If one or more parameters were poor, the intubating conditions were graded poor.

Table 2. Demographic data of the patients.

Demographic data	S-group	R-group	P value
Age (year)	63.1 ± 16.1	61.7 ± 13.0	0.795
Male / female (n)	9 / 6	11 / 4	0.439
Height (cm)	167.6 ± 10.3	169 ± 7.1	0.625
Weight (kg)	69.3 ± 16.3	67.2 ± 7.1	0.740
ASA value (2 / 3)	1 / 14	1 / 14	1

Legend: mean value ± SD, *statistically significant, S-group = succinylcholine group, R-group = rocuronium group

Table 3. Overall intubation conditions in the patients

	S-group	R-group	P value
Patients (n (%))	15 (100%)	15 (100%)	
Intubating conditions			
Excellent (n (%))	12 (80%)	6 (40%)	0.025*
Good (n (%))	3 (20%)	9 (60%)	
Poor (n (%))	0 (0%)	0 (0%)	

Legend: *statistically significant, S - group = succinylcholine group, R - group= rocuronium group

with poor intubation conditions. Intubation conditions in S-group were statistically significantly better than in R-group of patients (Table 3).

There were no statistically significant differences between groups comparing individual parameters which determine overall intubating conditions according to the grading system score designed by Viby-Morgenson et al. (Table 4; 22). In both groups we observed no resistance to laryngoscopy (Table 4). We observed better vocal cord position in the S-group, which was not statistically significant. In the R-group we observed one reaction to intubation with a slight limb movement and one movement of vocal cords during orotracheal intubation (Table 4)

There were no statistically significant differences in systolic and diastolic blood pressure before and after RSI between the groups (table 5). There was a statistically significant decrease in the systolic and diastolic blood pressure after RSI in both groups (table 5).

Before RSI there were no significant differences in the heart rate between the groups. After RSI, there was a statistically significant decrease in the heart rate in the S-group, while in the R-group we observed a small increase in the heart rate, which was not statistically significant (table 5).

There were no statistically significant differences in oxygen saturation—between the groups before and after RSI (table 5).

There were no significant differences be-

tween groups in serum potassium level before RSI, but after RSI the potassium level in the S-group was significantly higher in comparison to the R-group (Table 6). After the induction the potassium level increased significantly in the S-group and statistically significantly decreased in the R-group.

There were no significant differences between groups in serum myoglobin level before and after RSI, but after RSI serum myoglobin level increased in the S-group (which was not statistically significant) and statistically significantly decreased in the R-group (Table 6).

Table 4. Evaluation of intubating conditions in patients according to the grading system score designed by Viby-Morgenson et al. (22).

Grading system score	S-group	R-group	P value
Patients (n (%))	15 (100%)	15 (100%)	
Laryngoscopy			
Jaw relaxation			
Excellent	14 (93.33%)	14 (93.33%)	1
Good	1 (6.67%)	1 (6.67%)	
Poor	0 (0%)	0 (0%)	
Resistance to blade			
Excellent	15 (100%)	15 (100%)	1
Good	0 (0%)	0 (0%)	
Poor	0 (0%)	0 (0%)	
Vocal cords			
Position			
Excellent	12 (80%)	8 (53.33%)	0.121
Good	3 (20%)	7 (46.67%)	
Poor	0 (0%)	0 (0%)	
Movement			
Excellent	15 (100%)	14 (93.33%)	0.309
Good	0 (0%)	1 (6.67%)	
Poor	0 (0%)	0 (0%)	
Reaction to intubation			
Limb movement			
Excellent	15 (100%)	14 (93.33%)	0.309
Good	0 (0%)	1 (6.67%)	
Poor	0 (0%)	0 (0%)	
Coughing			
Excellent	15 (100%)	15 (100%)	1
Good	0 (0%)	0 (0%)	
Poor	0 (0%)	0 (0%)	

Legend: *statistically significant, S-group = succinylcholine group, R-group= rocuronium group

Table 5. Hemodynamic data and laboratory data of patients before and after intubation (S-group = succinylcholine group; R-group = rocuronium group).

Hemodynamic data			
(mean value \pm SD)	S-group	R-group	P value
SBP before RSI (mmHg)	156.4 \pm 26.1	154.8 \pm 28.5	0.874
after RSI (mmHg)	114.7 \pm 26.0**	117.9 \pm 22.5**	0.715
DBP before RSI (mmHg)	84.5 \pm 13.6	86.6 \pm 10.1	0.629
after RSI (mmHg)	66.0 \pm 12.4**	67.8 \pm 11.6**	0.685
HR before RSI (beats / min)	90.5 \pm 18.5	92.9 \pm 14.6	0.696
after RSI (beats / min)	78.9 \pm 18.1**	94.4 \pm 18.2	0.027*
SpO2 before RSI (%)	98.9 \pm 0.8	99.1 \pm 1.0	0.548
after RSI (%)	98.5 \pm 1.4	99.1 \pm 1.0	0.145
Potassium before RSI (mmol/l)	3.9 \pm 0.3	3.9 \pm 0.4	0.741
after RSI (mmol/l)	4.0 \pm 0.3	3.7 \pm 0.4**	0.019*
Myoglobin before RSI (μ g/l)	74.5 \pm 53.4	80.9 \pm 76.1	0.794
after RSI (μ g/l)	82.7 \pm 52.3	75.5 \pm 71.6**	0.755

Legend: SBP – systolic blood pressure, HR – heart rate, RSI – rapid sequence intubation, DBP – diastolic blood pressure, SpO2 – pulse oximetry, SD – standard deviation, mean value \pm SD

*- statistically significant between groups

** - statistically significant within group before and after intubation

DISCUSSION

Our study aimed to compare the intubation conditions in 30 patients with bowel obstruction using two different muscle relaxants. We compared 1.5mg/kg succinylcholine and 1.2mg/kg rocuronium, which are the dosages that should provide rapid and best intubation conditions (23, 28). Indirect laryngoscopy was performed 60 seconds after the injection of muscle relaxant. All patients in both groups were successfully intubated in the first attempt.

We observed statistically significant better intubation conditions in patients in the S-group than in R-group (table 3), according to the grading system score designed by Viby-Morgenson (22). But comparing individual parameters, which determine intubating condition according to grading system score designed by Viby-Morgenson there were no statistically significant differences between groups (Table 4). The main difference between the groups was in the vocal cords position (Table 4). According to our study, rocuronium 1.2mg/kg b.w. allowed excellent and good intubation conditions which are accepted as clinically good enough for successful orotracheal intubation, without increased incidence of aspiration.

Based on our results, we agree with the report by McCourt et al. that rocuronium 1mg/kg b.w. provides excellent and good intubation conditions, fulfilling the conditions for acceptable intubation conditions in the patients who are undergoing elective or emergency surgery (24). Luxen et al. also concluded that rocuronium, which has less side effects and nearly the same intubation condition, can be a good replacement for succinylcholine in intubation of emergency department patients (25).

Contrary to our results, Perry J et al. in the Cochrane review in 2003 compared intubating conditions between rocuronium 0.6mg/kg and succinylcholine 1mg/kg. They concluded the conditions were better when succinylcholine was used (26). In the last Cochrane review in 2017 Tran et al. compared intubation conditions between rocuronium 1.2mg/kg and succinylcholine 1mg/kg and found no statistically significant difference in intubation conditions. Despite their statistical results, they concluded due to succinylcholine shorter duration of action that succinylcholine created superior intubation conditions to rocuronium in achieving excellent and clinically acceptable intubating conditions

and rocuronium should only be used as an alternative to succinylcholine (27). Based on our results, we cannot agree with such conclusion, because rocuronium 1.2mg/kg allowed excellent clinical intubation conditions and has more properties as an 'ideal' muscle relaxant for RSI than succinylcholine (28 - 31).

There were no statistically significant differences in systolic blood pressure in both groups before and after induction of anesthesia. After the induction a statistically significant decrease in systolic blood pressure was observed in both groups. The decrease in systolic blood pressure was the consequence of induction drugs and mechanical ventilation after induction.

Heart rate decreased after RSI in the S-group but not in the R-group with statistically significant differences between the groups. Bradycardia is a well-known adverse effect of succinylcholine, which can also influence blood pressure, especially in critical ill patients undergoing emergency surgery due to bowel obstruction (9).

We observed an increase in potassium and myoglobin levels after RSI in the S-group and slight decrease in the R-group. Change in potassium levels between the groups was statistically significant. Sabo et al. also concluded that succinylcholine was associated with a modest increase in potassium concentration and these changes were not seen after rocuronium or sugammadex application (32). In some patients with acquired pathologic state, hyperkalemic response to succinylcholine can be remarkable, causing ventricular fibrillation and death (33, 34). In the literature some authors recommend precurarization with rocuronium before succinylcholine administration to reduce the incidence and severity of fasciculations and prevent an increase in serum potassium and myoglobin concentrations in adults and children (35-37).

But in our opinion, it is better to avoid using muscle relaxant with such life-threatening side effects and risk for anaphylactic reaction, which is higher if compared to rocuronium and then, after RSI, another immediately acting neuromuscular blocking drug has to be used, with its own risk for anaphylactic reaction, to maintain neuromuscular block during abdominal surgery (38).

We have to emphasize that in our study in both groups of patients we did not observe any regurgitation or aspiration, which are the major life-threatening complications during RSI in patients with bowel obstruction.

CONCLUSION

The results in the present study indicate that rocuronium in RSI patients with bowel obstruction enables the same intubation conditions as succinylcholine and the same risk of aspiration which allows succinylcholine replacement and avoidance of its side effects.

List of abbreviations

RSI: rapid sequence intubation; SBP: systolic blood pressure; DBP: diastolic blood pressure; SpO₂: pulse oximetry; HR: heart rate; SD: standard deviation; S-group: succinylcholine group; R-group: rocuronium group; ASA: American Society of Anesthesiology

DECLARATIONS

Ethics approval and consent to participate

The study was approved by the Republic of Slovenia National Medical Ethics Committee - NMEC on 29 October 2013 (Registration Number 104/10/13) and retrospectively registered with the ISRCTN registry on 4 December 2015 (Ref: ISRCTN11777647; 20).

Authors' contributions

All authors designed the study; LP recruited the patients, collected the data, performed preliminary data analysis and drafted the manuscript. MK performed detailed statistical analysis. All authors participated in the discussion. DM, MK and NKŠ revised the manuscript. All authors approved the final manuscript. DM is the corresponding author and is responsible for the finalization of the manuscript.

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